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EXAMINER
THANGAVELU, KANDASAMY

ART UNIT	PAPER NUMBER
2123	

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Please find below and/or attached an Office communication concerning this application or proceeding.

	Application No.	Applicant(s)
Office Action Summary	09/404,932	FRIEDL ET AL.
	Examiner	Art Unit
	Kandasamy Thangavelu	2123

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE <u>3</u> MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.
- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1) ☒ Responsive to communication(s) filed on <u>24 September 1999</u> .

2a) ☐ This action is **FINAL**. 2b) ☒ This action is non-final.

3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4) ☒ Claim(s) <u>1-25</u> is/are pending in the application.

    4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5) ☐ Claim(s) _____ is/are allowed.

6) ☒ Claim(s) <u>1-25</u> is/are rejected.

7) ☐ Claim(s) _____ is/are objected to.

8) ☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9) ☐ The specification is objected to by the Examiner.

10) ☒ The drawing(s) filed on <u>24 September 1999</u> is/are: a)☐ accepted or b)☒ objected to by the Examiner.

    Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

11) ☐ The proposed drawing correction filed on _____ is: a)☐ approved b)☐ disapproved by the Examiner.

    If approved, corrected drawings are required in reply to this Office action.

12) ☐ The oath or declaration is objected to by the Examiner.

Priority under 35 U.S.C. §§ 119 and 120

13) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

    a)☐ All b)☐ Some * c)☐ None of:

        1.☐ Certified copies of the priority documents have been received.

        2.☐ Certified copies of the priority documents have been received in Application No. _____ .

        3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

    * See the attached detailed Office action for a list of the certified copies not received.

14) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application).

    a) ☐ The translation of the foreign language provisional application has been received.

15) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)   4) ☐ Interview Summary (PTO-413) Paper No(s). _____ .

2) ☒ Notice of Draftsperson's Patent Drawing Review (PTO-948)   5) ☐ Notice of Informal Patent Application (PTO-152)

3) ☒ Information Disclosure Statement(s) (PTO-1449) Paper No(s) <u>5,6 & 7</u> .   6) ☐ Other:

DETAILED ACTION

Introduction

1.   Claims 1-25 of the application have been examined.

Information Disclosure Statement

2.   Acknowledgment is made of the information disclosure statements filed on

September 20, 2000, February 15, 2001 and January 18, 2002 together with copies of

the patents and papers. The patents and papers have been considered in reviewing the

claims.

Drawings

3.   The draft person has objected to the drawings; see a copy of Form PTO-948 for

an explanation.

Claim Rejections - 35 USC § 103

4.   The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all

obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set
> forth in section 102 of this title, if the differences between the subject matter sought to be patented and

the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains.

5.   The factual inquiries set forth in *Graham* v. *John Deere Co.*, 383 U.S. 1, 148 USPQ 459

(1966), that are applied for establishing a background for determining obviousness under 35

U.S.C. 103(a) are summarized as follows:

1.   Determining the scope and contents of the prior art.
2.   Ascertaining the differences between the prior art and the claims at issue.
3.   Resolving the level of ordinary skill in the pertinent art.
4.   Considering objective evidence present in the application indicating obviousness or nonobviousness.

6.   Claims 1-21 are rejected under 35 U.S.C. 103(a) as being unpatentable over **Yu et al.**

(YU) (U.S. Patent 6,096,088) in view of **Kennedy (KE)** ("Flow Analysis of Injection Molds",

Hanser Publishers, 1995).

6.1   **Yu** teaches Method for modeling three dimension objects and simulation of fluid flow.

Specifically, as per Claim 1, **YU** teaches a method for modeling injection of a fluid into a mold

defining a three dimensional cavity (Abs, L1-3; Fig. 15; CL1, L5-10); the method comprising the

steps of:

        (a) providing a three-dimensional solid computer model defining the cavity (CL1, L11-

13; CL1, L58-61);

        (b) discretizing a solution domain based on the solid model (CL2, L14-20; CL2, L22-24);

and

(f) determining whether at least one of the respective filling phase solutions and packing

phase solutions are acceptable (CL13, L27-33).

YU does not expressly teach (c) specifying boundary conditions. KE teaches specifying

boundary conditions (Pg 5, Para 3; Pg 150, Eq 9.4-9.9; Pg 186, Eq 10.5-10.9), as boundary

conditions are physical effects that cause the system to change; boundary conditions restrict the

number of possible solutions and ensure a unique solution to the problem under consideration

(Pg. 110, Para 7). It would have been obvious to one of ordinary skill in the art at the time of

Applicants' invention to modify the method of YU with the method of KE that included

specifying boundary conditions, as boundary conditions are physical effects that cause the

system to change; boundary conditions would restrict the number of possible solutions and

ensure a unique solution to the problem under consideration.

YU teaches filling phase and solving for filling phase process variables (CL1, L13-18;

CL13, L12-27). YU does not expressly teach (d) solving for filling phase process variables using

conservation of mass, conservation of momentum, and conservation of energy equations for at

least a portion of the solution domain based on the boundary conditions to provide respective

filling solutions therefor for at least the portion of the solution domain. KE teaches (d) solving

for filling phase process variables using conservation of mass, conservation of momentum, and

conservation of energy equations for at least a portion of the solution domain based on the

boundary conditions to provide respective filling solutions therefor for at least the portion of the

solution domain (Pg 59, Para 1; Pg 113, Para 6; Pg 149, Para 1 to Pg 152, Para 3), as

conservation of mass means that the mass contained in a volume does not change (Pg 44, Sec

4.2); conservation of momentum requires that the time rate of change of the fluid momentum in a

volume is equal to the sum of external forces acting on the volume (Pg 46, Sec 4.3); conservation

of energy means that the total energy of fluid in a volume is given by the sum of kinetic and

internal energies (Pg 47, Sec 4.4); boundary conditions are physical effects that cause the system

to change; boundary conditions restrict the number of possible solutions and ensure a unique

solution to the problem under consideration (Pg. 110, Para 7). As per **YU**, on the basis of

calculated data and derived information, changes to the component geometry, position of the

injection locations, processing conditions and material of the molding may be evaluated for their

efficacy in improving the quality or manufacturability of part (CL13, L27-33). It would have

been obvious to one of ordinary skill in the art at the time of Applicants' invention to modify the

method of **YU** with the method of **KE** that included (d) solving for filling phase process

variables using conservation of mass, conservation of momentum, and conservation of energy

equations for at least a portion of the solution domain based on the boundary conditions to

provide respective filling solutions therefor for at least the portion of the solution domain, as

conservation of mass would mean that the mass contained in a volume would not change;

conservation of momentum would require that the time rate of change of the fluid momentum in

a volume would be equal to the sum of external forces acting on the volume; conservation of

energy would mean that the total energy of fluid in a volume would be given by the sum of

kinetic and internal energies; boundary conditions are physical effects that would cause the

system to change; boundary conditions would restrict the number of possible solutions and

would ensure a unique solution to the problem under consideration. On the basis of calculated

data and derived information, changes to the component geometry, position of the injection

locations, processing conditions and material of the molding might be evaluated for their efficacy

in improving the quality or manufacturability of part.

YU teaches packing phase and solving for packing phase process variables (CL1, L13-

18; CL13, L12-27). **YU** does not expressly teach (e) solving for packing phase process variables

using conservation of mass, conservation of momentum, and conservation of energy equations

for at least a portion of the solution domain based on respective states of the process variables at

termination of filling, to provide respective packing phase solutions therefor for at least the

portion of the solution domain. **KE** teaches (e) solving for packing phase process variables using

conservation of mass, conservation of momentum, and conservation of energy equations for at

least a portion of the solution domain based on respective states of the process variables at

termination of filling, to provide respective packing phase solutions therefor for at least the

portion of the solution domain (Pg 107, Sec 6.7; Pg 113, Para 6; Pg 185, Para 1 to pg 188, Para

2), as conservation of mass means that the mass contained in a volume does not change (Pg 44,

Sec 4.2); conservation of momentum requires that the time rate of change of the fluid momentum

in a volume is equal to the sum of external forces acting on the volume (Pg 46, Sec 4.3);

conservation of energy means that the total energy of fluid in a volume is given by the sum of

kinetic and internal energies (Pg 47, Sec 4.4); boundary conditions are physical effects that cause

the system to change; boundary conditions restrict the number of possible solutions and ensure a

unique solution to the problem under consideration (Pg. 110, Para 7). As per **YU**, on the basis of

calculated data and derived information, changes to the component geometry, position of the

injection locations, processing conditions and material of the molding may be evaluated for their

efficacy in improving the quality or manufacturability of part (CL13, L27-33). It would have

been obvious to one of ordinary skill in the art at the time of Applicants' invention to modify the

method of **YU** with the method of **KE** that included (e) solving for packing phase process

variables using conservation of mass, conservation of momentum, and conservation of energy

equations for at least a portion of the solution domain based on respective states of the process

variables at termination of filling, to provide respective packing phase solutions therefor for at

least the portion of the solution domain, as conservation of mass would mean that the mass

contained in a volume would not change; conservation of momentum would require that the time

rate of change of the fluid momentum in a volume would be equal to the sum of external forces

acting on the volume; conservation of energy would mean that the total energy of fluid in a

volume would be given by the sum of kinetic and internal energies; boundary conditions are

physical effects that would cause the system to change; boundary conditions would restrict the

number of possible solutions and would ensure a unique solution to the problem under

consideration. On the basis of calculated data and derived information, changes to the

component geometry, position of the injection locations, processing conditions and material of

the molding might be evaluated for their efficacy in improving the quality or manufacturability

of part.

Dependent claims:

Per Claim 2: **YU** and **KE** teach the method of Claim 1. **YU** teaches that the filling phase

process variables and packing phase process variables are selected from the group consisting of

density, fluidity, mold cavity fill time, mold cavity packing time, pressure, shear rate, shear

stress, temperature, velocity, viscosity, and volumetric shrinkage (CL13, L14-27).

Per Claim 3: **YU** and **KE** teach the method of Claim 1. **YU** teaches (g) modifying at least

one of the discretized solution domain and the boundary conditions in the event at least one of

the respective filling phase solutions and packing phase solutions is determined to be

unacceptable (CL13, L27-41); and

(h) repeating steps (d) through (g), iteratively, until the respective filling phase solutions

or packing phase solutions are determined to be acceptable (CL13, L27-38).

Per Claim 4: **YU** teaches computing a filling phase solution consisting of fill time,

pressure, shear rate, shear stress, temperature, velocity, and viscosity (CL13, L14-27). **YU** does

not expressly teach displaying in graphics format a filling phase solution selected from the group

consisting of fill time, pressure, shear rate, shear stress, temperature, velocity, and viscosity. **KE**

teaches displaying in graphics format a filling phase solution selected from the group consisting

of fill time, pressure, shear rate, shear stress, temperature, velocity, and viscosity (Pg 114, Para 1;

Pg 149, Para 1 to Pg 152, Para 3), as analysis results in the tabular format are difficult to interpret

and graphical displays can plot contours of the calculated variables over the model of the part for

easy interpretation (Pg 114, Para 1). It would have been obvious to one of ordinary skill in the

art at the time of Applicants' invention to modify the method of **YU** with the method of **KE** that

included displaying in graphics format a filling phase solution selected from the group consisting

of fill time, pressure, shear rate, shear stress, temperature, velocity, and viscosity, as analysis

results in the tabular format would be difficult to interpret and graphical displays could plot

contours of the calculated variables over the model of the part for easy interpretation.

Per Claim 5: **YU** teaches computing a packing phase solution consisting of density,

packing time, pressure, shear rate, temperature, velocity, viscosity, and volumetric shrinkage

(CL13, L14-27). **YU** does not expressly teach displaying in graphics format a packing phase

solution selected from the group consisting of density, packing time, pressure, shear rate,

temperature, velocity, viscosity, and volumetric shrinkage. **KE** teaches displaying in graphics

format a packing phase solution selected from the group consisting of density, packing time,

pressure, shear rate, temperature, velocity, viscosity, and volumetric shrinkage (Pg 114, Para 1;

Pg 185, Para 1 to Pg 188, Para 2), as analysis results in the tabular format are difficult to interpret

and graphical displays can plot contours of the calculated variables over the model of the part for

easy interpretation (Pg 114, Para 1). It would have been obvious to one of ordinary skill in the

art at the time of Applicants' invention to modify the method of **YU** with the method of **KE** that

included displaying in graphics format a filling phase solution selected from the group consisting

of fill time, pressure, shear rate, shear stress, temperature, velocity, and viscosity, as analysis

results in the tabular format would be difficult to interpret and graphical displays could plot

contours of the calculated variables over the model of the part for easy interpretation.

6.2   As per Claim 6, **YU** teaches a method for modeling injection of a fluid into a mold

defining a three dimensional cavity (Abs, L1-3; Fig. 15; CL1, L5-10); the method comprising the

steps of:

        (a) providing a three-dimensional solid computer model defining the cavity (CL1, L11-

13; CL1, L58-61);

        (b) discretizing a solution domain based on the solid model (CL2, L14-20; CL2, L22-24);

and

(e) determining whether the respective solutions are acceptable for injection of the fluid

during filling of the mold cavity (CL13, L27-33).

YU does not expressly teach (c) specifying boundary conditions. **KE** teaches specifying

boundary conditions (Pg 5, Para 3; Pg 150, Eq 9.4-9.9; Pg 186, Eq 10.5-10.9), as boundary

conditions are physical effects that cause the system to change; boundary conditions restrict the

number of possible solutions and ensure a unique solution to the problem under consideration

(Pg. 110, Para 7). It would have been obvious to one of ordinary skill in the art at the time of

Applicants' invention to modify the method of **YU** with the method of **KE** that included

specifying boundary conditions, as boundary conditions are physical effects that cause the

system to change; boundary conditions would restrict the number of possible solutions and

ensure a unique solution to the problem under consideration.

YU teaches filling phase and solving for filling phase process variables (CL1, L13-18;

CL13, L12-27). **YU** does not expressly teach (d) solving for filling phase process variables using

conservation of mass, conservation of momentum, and conservation of energy equations for at

least a portion of the solution domain based on the boundary conditions to provide respective

filling solutions therefor for at least the portion of the solution domain. **KE** teaches (d) solving

for filling phase process variables using conservation of mass, conservation of momentum, and

conservation of energy equations for at least a portion of the solution domain based on the

boundary conditions to provide respective filling solutions therefor for at least the portion of the

solution domain (Pg 59, Para 1; Pg 113, Para 6; Pg 149, Para 1 to Pg 152, Para 3), as

conservation of mass means that the mass contained in a volume does not change (Pg 44, Sec

4.2); conservation of momentum requires that the time rate of change of the fluid momentum in a

volume is equal to the sum of external forces acting on the volume (Pg 46, Sec 4.3); conservation

of energy means that the total energy of fluid in a volume is given by the sum of kinetic and

internal energies (Pg 47, Sec 4.4); boundary conditions are physical effects that cause the system

to change; boundary conditions restrict the number of possible solutions and ensure a unique

solution to the problem under consideration (Pg. 110, Para 7). As per **YU**, on the basis of

calculated data and derived information, changes to the component geometry, position of the

injection locations, processing conditions and material of the molding may be evaluated for their

efficacy in improving the quality or manufacturability of part (CL13, L27-33). It would have

been obvious to one of ordinary skill in the art at the time of Applicants' invention to modify the

method of **YU** with the method of **KE** that included (d) solving for filling phase process

variables using conservation of mass, conservation of momentum, and conservation of energy

equations for at least a portion of the solution domain based on the boundary conditions to

provide respective filling solutions therefor for at least the portion of the solution domain, as

conservation of mass would mean that the mass contained in a volume would not change;

conservation of momentum would require that the time rate of change of the fluid momentum in

a volume would be equal to the sum of external forces acting on the volume; conservation of

energy would mean that the total energy of fluid in a volume would be given by the sum of

kinetic and internal energies; boundary conditions are physical effects that would cause the

system to change; boundary conditions would restrict the number of possible solutions and

would ensure a unique solution to the problem under consideration. On the basis of calculated

data and derived information, changes to the component geometry, position of the injection

locations, processing conditions and material of the molding might be evaluated for their efficacy

in improving the quality or manufacturability of part.

Dependent claims:

Per Claim 7: **YU** and **KE** teach the method of Claim 6. **YU** teaches that the discretizing

step (b) comprises the substep of generating a finite element mesh based on the solid model by

subdividing the model into a plurality of connected elements defined by a plurality of nodes

(CL2, L14-20; CL2, L22-24).

Per Claim 8: **YU** does not expressly teach that the boundary conditions are selected from

the group consisting of fluid composition, fluid injection location, fluid injection temperature,

fluid injection pressure, fluid injection volumetric flow rate, mold temperature, cavity

dimensions, cavity configuration, and mold parting plane, and variations thereof. **KE** teaches

that the boundary conditions are selected from the group consisting of fluid composition, fluid

injection location, fluid injection temperature, fluid injection pressure, fluid injection volumetric

flow rate, mold temperature, cavity dimensions, cavity configuration, and mold parting plane,

and variations thereof (Pg 5, Para 3; Pg 150, Eq 9.4-9.9; Pg 186, Eq 10.5-10.9), as boundary

conditions are physical effects that cause the system to change; boundary conditions restrict the

number of possible solutions and ensure a unique solution to the problem under consideration

(Pg. 110, Para 7). It would have been obvious to one of ordinary skill in the art at the time of

Applicants' invention to modify the method of **YU** with the method of **KE** that included the

boundary conditions selected from the group consisting of fluid composition, fluid injection

location, fluid injection temperature, fluid injection pressure, fluid injection volumetric flow rate,

mold temperature, cavity dimensions, cavity configuration, and mold parting plane, and

variations thereof, as boundary conditions are physical effects that cause the system to change;

boundary conditions would restrict the number of possible solutions and ensure a unique solution

to the problem under consideration.

Per Claim 9: **YU** does not expressly teach that the solving step (d) utilizing the

conservation of mass and conservation of momentum equations comprises the substeps of:

(i)   solving for fluidity for at least some of the portion of the solution domain;

(ii)   solving for pressure for at least some of the portion of the solution domain; and

(iii)   calculating velocity for at least some of the portion of the solution domain.

KE teaches that the solving step (d) utilizing the conservation of mass and conservation

of momentum equations (Pg 149, Para 1 to Pg 152, Para 3) comprises the substeps of:

(i)   solving for fluidity for at least some of the portion of the solution domain;

(ii)   solving for pressure for at least some of the portion of the solution domain; and

(iii)   calculating velocity for at least some of the portion of the solution domain (Pg

151, Para 1 to Pg 152, Para 3), because as per **YU**, on the basis of calculated data and derived

information, changes to the component geometry, position of the injection locations, processing

conditions and material of the molding may be evaluated for their efficacy in improving the

quality or manufacturability of part (CL13, L27-33).   It would have been obvious to one of

ordinary skill in the art at the time of Applicants' invention to modify the method of **YU** with the

method of **KE** that included that the solving step (d) utilizing the conservation of mass and

conservation of momentum equations comprising the substeps of:

(i)   solving for fluidity for at least some of the portion of the solution domain;

(ii)   solving for pressure for at least some of the portion of the solution domain; and

(iii)   calculating velocity for at least some of the portion of the solution domain,

because on the basis of calculated data and derived information, changes to the component

geometry, position of the injection locations, processing conditions and material of the molding

might be evaluated for their efficacy in improving the quality or manufacturability of part.

Per Claims10-15: **YU** does not expressly teach the solving step (d) utilizing the

conservation of energy equation comprises the substep of calculating viscosity for at least some

of the portion of the solution domain; the viscosity calculating substep is based on temperature;

at least one of velocity and viscosity is calculated iteratively, until pressure converges; the

substep of determining free surface evolution of the fluid in the cavity based on velocity; the

substep of calculating temperature based on at least one of a convective heat transfer

contribution, a conductive heat transfer contribution, and a viscous dissipation contribution; free

surface evolution is determined iteratively, until the cavity is filled. **KE** teaches that the solving

step (d) utilizing the conservation of energy equation comprises the substep of calculating

viscosity for at least some of the portion of the solution domain; the viscosity calculating substep

is based on temperature; at least one of velocity and viscosity is calculated iteratively, until

pressure converges; the substep of determining free surface evolution of the fluid in the cavity

based on velocity; the substep of calculating temperature based on at least one of a convective

heat transfer contribution, a conductive heat transfer contribution, and a viscous dissipation

contribution; free surface evolution is determined iteratively, until the cavity is filled (Pg 151,

Para 1 to Pg 152, Para 3), because as per **YU**, on the basis of calculated data and derived

information, changes to the component geometry, position of the injection locations, processing

conditions and material of the molding may be evaluated for their efficacy in improving the

quality or manufacturability of part (CL13, L27-33).

It would have been obvious to one of ordinary skill in the art at the time of Applicants'

invention to modify the method of **YU** with the method of **KE** that included the solving step (d)

utilizing the conservation of energy equation comprising the substep of calculating viscosity for

at least some of the portion of the solution domain; the viscosity calculating substep being based

on temperature; at least one of velocity and viscosity being calculated iteratively, until pressure

converges; the substep of determining free surface evolution of the fluid in the cavity based on

velocity; the substep of calculating temperature based on at least one of a convective heat

transfer contribution, a conductive heat transfer contribution, and a viscous dissipation

contribution; free surface evolution being determined iteratively, until the cavity is filled,

because as per **YU**, on the basis of calculated data and derived information, changes to the

component geometry, position of the injection locations, processing conditions and material of

the molding may be evaluated for their efficacy in improving the quality or manufacturability of

part.

Per Claim 16: **YU** teaches packing phase and solving for packing phase process variables

(CL1, L13-18; CL13, L12-27). **YU** does not expressly teach (f) solving for packing phase

process variables using conservation of mass, conservation of momentum, and conservation of

energy equations for at least a portion of the solution domain based on respective states of the

process variables at termination of filling, to provide respective packing phase solutions therefor

for at least the portion of the solution domain. **KE** teaches (e) solving for packing phase process

variables using conservation of mass, conservation of momentum, and conservation of energy

equations for at least a portion of the solution domain based on respective states of the process

variables at termination of filling, to provide respective packing phase solutions therefor for at

least the portion of the solution domain (Pg 107, Sec 6.7; Pg 113, Para 6; Pg 185, Para 1 to pg

188, Para 2), as conservation of mass means that the mass contained in a volume does not change

(Pg 44, Sec 4.2); conservation of momentum requires that the time rate of change of the fluid

momentum in a volume is equal to the sum of external forces acting on the volume (Pg 46, Sec

4.3); conservation of energy means that the total energy of fluid in a volume is given by the sum

of kinetic and internal energies (Pg 47, Sec 4.4); boundary conditions are physical effects that

cause the system to change; boundary conditions restrict the number of possible solutions and

ensure a unique solution to the problem under consideration (Pg. 110, Para 7). As per **YU**, on

the basis of calculated data and derived information, changes to the component geometry,

position of the injection locations, processing conditions and material of the molding may be

evaluated for their efficacy in improving the quality or manufacturability of part (CL13, L27-33).

It would have been obvious to one of ordinary skill in the art at the time of Applicants' invention

to modify the method of **YU** with the method of **KE** that included (e) solving for packing phase

process variables using conservation of mass, conservation of momentum, and conservation of

energy equations for at least a portion of the solution domain based on respective states of the

process variables at termination of filling, to provide respective packing phase solutions therefor

for at least the portion of the solution domain, as conservation of mass would mean that the mass

contained in a volume would not change; conservation of momentum would require that the time

rate of change of the fluid momentum in a volume would be equal to the sum of external forces

acting on the volume; conservation of energy would mean that the total energy of fluid in a

volume would be given by the sum of kinetic and internal energies; boundary conditions are

physical effects that would cause the system to change; boundary conditions would restrict the

number of possible solutions and would ensure a unique solution to the problem under

consideration. On the basis of calculated data and derived information, changes to the

component geometry, position of the injection locations, processing conditions and material of

the molding might be evaluated for their efficacy in improving the quality or manufacturability

of part.

(g) determining whether the respective packing phase solutions are acceptable for

injection of the fluid during filling of the mold cavity (CL13, L27-33).

Per Claim 17: **YU** does not expressly teach that the solving step (f) utilizing the

conservation of mass and conservation of momentum equations comprises the substeps of:

(i)   solving for fluidity for at least some of the portion of the solution domain;

(ii)   solving for pressure for at least some of the portion of the solution domain; and

(iii)   calculating velocity for at least some of the portion of the solution domain.

KE teaches that the solving step (f) utilizing the conservation of mass and conservation

of momentum equations (Pg 185, Para 1 to Pg 186, Eq 4) comprises the substeps of:

    (i)   solving for fluidity for at least some of the portion of the solution domain;

    (ii)   solving for pressure for at least some of the portion of the solution domain; and

    (iii)   calculating velocity for at least some of the portion of the solution domain (Pg

185, Para 1 to Pg 188, Para 2), because as per **YU**, on the basis of calculated data and derived

information, changes to the component geometry, position of the injection locations, processing

conditions and material of the molding may be evaluated for their efficacy in improving the

quality or manufacturability of part (CL13, L27-33).   It would have been obvious to one of

ordinary skill in the art at the time of Applicants' invention to modify the method of **YU** with the

method of **KE** that included that the solving step (f) utilizing the conservation of mass and

conservation of momentum equations comprising the substeps of:

    (i)   solving for fluidity for at least some of the portion of the solution domain;

    (ii)   solving for pressure for at least some of the portion of the solution domain; and

    (iii)   calculating velocity for at least some of the portion of the solution domain,

because on the basis of calculated data and derived information, changes to the component

geometry, position of the injection locations, processing conditions and material of the molding

might be evaluated for their efficacy in improving the quality or manufacturability of part.

Per Claims18-21: **YU** does not expressly teach the solving step (f) utilizing the

conservation of energy equation comprises the substep of calculating viscosity for at least some

of the portion of the solution domain; the viscosity calculating substep is based on temperature;

at least one of velocity and viscosity is calculated iteratively, until pressure converges; the

substep of calculating temperature based on at least one of a convective heat transfer

contribution, a conductive heat transfer contribution, and a viscous dissipation contribution. **KE**

teaches that the solving step (f) utilizing the conservation of energy equation comprises the

substep of calculating viscosity for at least some of the portion of the solution domain; the

viscosity calculating substep is based on temperature; at least one of velocity and viscosity is

calculated iteratively, until pressure converges; the substep of calculating temperature based on

at least one of a convective heat transfer contribution, a conductive heat transfer contribution,

and a viscous dissipation contribution (Pg 185, Para 1 to Pg 188, Para 2), because as per **YU**, on

the basis of calculated data and derived information, changes to the component geometry,

position of the injection locations, processing conditions and material of the molding may be

evaluated for their efficacy in improving the quality or manufacturability of part (CL13, L27-33).

It would have been obvious to one of ordinary skill in the art at the time of Applicants'

invention to modify the method of **YU** with the method of **KE** that included the solving step (f)

utilizing the conservation of energy equation comprising the substep of calculating viscosity for

at least some of the portion of the solution domain; the viscosity calculating substep being based

on temperature; at least one of velocity and viscosity being calculated iteratively, until pressure

converges; the substep of calculating temperature based on at least one of a convective heat

transfer contribution, a conductive heat transfer contribution, and a viscous dissipation

contribution, because on the basis of calculated data and derived information, changes to the

component geometry, position of the injection locations, processing conditions and material of

the molding may be evaluated for their efficacy in improving the quality or manufacturability of

part.

7.   Claims 22-24 are rejected under 35 U.S.C. 103(a) as being unpatentable over **Yu et al.**

(YU) (U.S. Patent 6,096,088) in view of **Kennedy (KE)** ("Flow Analysis of Injection Molds",

Hanser Publishers, 1995), and further in view of **Haverty (HA)** (U.S. Patent 5,989,473).

7.1   As per Claim 22, **YU** and **KE** teach the method of Claim 21. **YU** and **KE** do not

expressly teach (h) calculating mass properties of a component produced in accordance with the

boundary conditions. Per claim 23, **YU** and **KE** do not expressly teach the mass properties are

selected from the group consisting of component density, volumetric shrinkage, component

mass, and component volume. **HA** teaches calculating mass properties of a component produced

in accordance with the boundary conditions; and the mass properties are selected from the group

consisting of component density, volumetric shrinkage, component mass, and component

volume (CL 7, L13-43), because as per **YU**, on the basis of calculated data and derived

information, changes to the component geometry, position of the injection locations, processing

conditions and material of the molding may be evaluated for their efficacy in improving the

quality or manufacturability of part (CL13, L27-33). It would have been obvious to one of

ordinary skill in the art at the time of Applicants' invention to modify the method of **YU** and **KE**

with the method of **HA** that included calculating mass properties of a component produced in

accordance with the boundary conditions; and the mass properties would be selected from the

group consisting of component density, volumetric shrinkage, component mass, and component

volume, because on the basis of calculated data and derived information, changes to the

component geometry, position of the injection locations, processing conditions and material of

the molding may be evaluated for their efficacy in improving the quality or manufacturability of

part.

7.2   Per Claim 24: **Y, KE** and **HA** teach the method of Claim 22. **YU** and **HA** do not

expressly teach that at least one of velocity, viscosity, and mass properties is calculated

iteratively, until a predetermined pressure profile is completed. **KE** teaches that at least one of

velocity, viscosity, and mass properties is calculated iteratively, until a predetermined pressure

profile is completed (Pg 188, Para 2), because as per **YU**, on the basis of calculated data and

derived information, changes to the component geometry, position of the injection locations,

processing conditions and material of the molding may be evaluated for their efficacy in

improving the quality or manufacturability of part (CL13, L27-33). It would have been obvious

to one of ordinary skill in the art at the time of Applicants' invention to modify the method of

YU and **HA** with the method of **KE** that included at least one of velocity, viscosity, and mass

properties being calculated iteratively, until a predetermined pressure profile is completed, as on

the basis of calculated data and derived information, changes to the component geometry,

position of the injection locations, processing conditions and material of the molding may be

evaluated for their efficacy in improving the quality or manufacturability of part.

8.   Claim 25 is rejected under 35 U.S.C. 103(a) as being unpatentable over **Yu et al. (YU)**

(U.S. Patent 6,096,088) in view of **Kennedy (KE)** ("Flow Analysis of Injection Molds", Hanser

Publishers, 1995), and further in view of **Talwer et al. (TA)** ("Three dimensional simulation of

polymer injection molding: verification", July 1998).

8.1   As per Claim 25, **YU** and **KE** teach the method of Claim 7. **YU** and **KE** do not expressly

teach that the mesh generating substep comprises generating an anisotropic mesh in thick and

thin zones such that mesh refinement provides increased resolution in a thickness direction

without increasing substantially mesh refinement in a longitudinal direction. **TA** teaches that the

mesh generating substep comprises generating an anisotropic mesh in thick and thin zones such

that mesh refinement provides increased resolution in a thickness direction without increasing

substantially mesh refinement in a longitudinal direction (Pg 53, CL1, Para 4 to CL2, Para 2), as

the simulation process is made more effective in usage of resources by the employment of an

anisotropic mesh that refines the mesh in the transverse direction to the flow (Pg 57, CL1, Para

2). It would have been obvious to one of ordinary skill in the art at the time of Applicants'

invention to modify the method of **YU** and **KE** with the method of **TA** that included the mesh

generating substep comprising generating an anisotropic mesh in thick and thin zones such that

mesh refinement provides increased resolution in a thickness direction without increasing

substantially mesh refinement in a longitudinal direction, the simulation process would be made

more effective in usage of resources by the employment of an anisotropic mesh that refines the

mesh in the transverse direction to the flow.

Conclusion

9.   The prior art made of record and not relied upon is considered pertinent to the

Applicants' disclosure.

The following patents and papers are cited to further show the state of the art at the time of Applicants' invention with respect to three-dimensional simulation of injection molding.

1. Mori et al., "Simplified three dimensional simulation of non-isothermal filling in metal injection moulding by finite element method", Engineering computations, 1996.

2. Ding et al., "Finite element simulation of an injection moulding process", International journal of numerical methods for heat and fluid flow, 1997.

10.   Any inquiry concerning this communication or earlier communications from the examiner should be directed to Dr. Kandasamy Thangavelu whose telephone number is 703-305-0043. The examiner can normally be reached on Monday through Friday from 8:00 AM to 5:30 PM.

If attempts to reach examiner by telephone are unsuccessful, the examiner's supervisor, Kevin Teska, can be reached on (703) 305-9704. The fax phone number for the organization where this application or proceeding is assigned is 703-746-7329.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the receptionist whose telephone number is 703-305-9600.

K. Thangavelu
Art Unit 2123
August 21, 2003

SAMUEL BRODA, ESQ.
PRIMARY EXAMINER